

A horizontal band across the middle of the page features a blurred photograph of a ceiling with several circular recessed lights, creating a bokeh effect.

Lighting Strategies & Technologies

California Lighting Technology Center

RESEARCH

1554 Drew Ave. Davis, CA 95816 | cltc.ucdavis.edu | PH: 530-754-7515 F: 530-754-7514

INNOVATION

PARTNERSHIP

Strategies & Technologies

Residential

1. Super CFLs
2. LED Kitchen Lighting
3. Residential Occupancy Controls

Commercial

1. Task/Ambient Office Lighting
2. Office Lighting Controls
3. Bi-level Exterior Lighting

Additional Commercial Opportunities

1. Bi-Level Stairwell Lighting
2. LED Freezer Case Lighting
3. Bi-level Corridor Lighting

Super CFLs

High quality CFLs that people want to buy

- Low Color Temperature (warm yellow light)
- Hi Color Rendering (ability to render colors)
- Dimmability
- Longevity



Super CFLs

- Energy savings: **6,400 – 11,700 GWhr/yr**
- Carbon offset:
2.1 – 3.8 M metric tons of CO₂/yr
(724 lb CO₂/MWh, EPA eGRID data for CA area)
- 70% of medium screw base sockets
have incandescent lamps =
about 25 sockets/household (KEMA, 2009)
= 336 million potential sockets



13.3 million households in California in 2009 (estimated, pre & post T-24 2005)

Potential installed wattage reduction 13.9 GW

Assume an average socket operation of 1.25–2.3 hr/day, (456-840 hr/yr)

Average incandescent wattage 59 W, vs. average CFL wattage 17 W (KEMA, 2009)



Super CFLs

- Maintenance issues
 - None
 - Longevity benefits
- Environmental issues
 - Significant disposal issues
- Market potential
 - 70% of all medium screw-base residential sockets
- Transformation issues
 - Need for educational programs
 - Need to restore consumer perception & expectations

LED Kitchen Lighting

- Downlights
- Under Cabinet



LED Kitchen Lighting

- 11.9 million Pre-Title 24 2005 homes
- Approximately 107 – 427 W savings per incandescent kitchen
(assuming 2 to 8 recessed cans)
- Energy Savings: **1.6 – 6.5 thousand GWhr/yr**
- Carbon offset: **0.5 – 2.1 million metric tons of CO₂/yr**

1.3 to 5.1 GW x 3.5 hrs/day x 356 days = 1.6-6.5 thousand GWh/yr

LED Kitchen Lighting

- Maintenance issues
 - No issues
 - Long source life reduces maintenance needs
- Environmental issues
 - Unregulated, poorly designed products may enter waste stream prematurely
- Market potential
 - Majority of all homes as a retrofit
 - May displace mercury-based lamps
- Transformation issues
 - Need for educational training programs
 - Large procurement issues

Residential Occupancy Controls

- 50% potential savings
- Two room (bathroom + laundry) savings:
798 – 1,793 GWh/yr
- Carbon offset:
262 – 589 thousand metric tons CO₂/yr



One bathroom per home

$58 - 225 \text{ kWh} \times 11.9 \text{ million homes} \times 0.50 \text{ savings} = 345 - 1,341 \text{ GWh}$

One additional small space per home (laundry / garage)

$76 \text{ kWh} \times 11.9 \text{ million homes} \times 0.50 \text{ savings} = 452 \text{ GWh}$

Residential Occupancy Controls

- Maintenance issues
 - None
- Environmental issues
 - None
- Market potential
 - Majority of residences (approximately 11.9 million homes)
- Transformation Needs
 - Large procurement
 - Third party programs
 - Rebates
 - Educational programs



Residential Savings Summary

	Energy savings (1000 GWh/yr)		Carbon offset (million metric tons CO ₂)		Total CA lighting electricity consumption in residences (1000 GWh/yr)	From	To
	From	To	From	To			
Super CFLs	6.4	11.7	2.1	3.8	19.8	32%	59%
LED Kitchen Lighting (downlights)	1.6	6.5	0.5	2.1		8%	33%
Residential Occupancy Controls (bath + laundry)	0.8	1.8	0.3	0.6		4%	9%

Task/Ambient Office Lighting

50% savings through

- Lower overhead ambient lighting
- Low power task lights



Task/Ambient Lighting

UC Davis Study: Reduction from 1.6 to 0.8 W/sf

- Energy Savings: **4.3 GWh/yr**
- Cost Savings: **\$562,432/yr**
- Cost Savings over 10 years: **\$5.6M**
- Payback: less than 10 years



UCDAVIS

2.6 million square ft of office space:
~10,000 offices, 260 sq feet each

Current Electricity Use & Cost:

8,652,800 kWh/year x \$.13 kWh = \$1,124,864 /year

50% reduction: 4,326,400 kWh/year

Cost:

\$1 sq/ft for controls = \$2,600,000

\$250 per office for equipment = \$2,500,000

Total: \$5,100,000

Task/Ambient Lighting

**California-wide application:
Reduction from 1.5 to 0.7 W/sf**

- Energy savings: **3096 GWh/yr** ^[3]
- Demand reduction: **794 MW**
- Cost savings: **\$396 M/yr** ^[4]



Total office space in CA = 1.13 billion sq. ft. [1]

Demand savings per sq. ft. of office space = .7 W/sq. ft. [2]

Notes on next slide

Average generating capacity of a coal fired power plant [5] = 225 MW

California could postpone/avoid building approx. 3.5 power plants by implementing task/ambient lighting in all existing commercial office space.

Task/Ambient Lighting Notes (previous slide)

1. Estimate is based on the 2003 CEBCS Study. Study provides total office floor space for the “Western” region – California, Oregon, Washington. Estimate is based on assuming that the floor space attributable to California is linearly proportional to its population density when compared to the population density of Oregon and Washington. This equates to 63% of the floor space in the Western region belonging to California.
2. 2008 Buildings Energy Data Book states that large offices (>25,000 sq. ft) have a lighting power density of 1.3-1.8 W/ft², and small offices (<25,000 sq. ft) have a lighting power density of 1.7-2.2 W/ft².
3. Estimate is based on a annual occupied hours of 3898. This is a weighted average of the numbers for small and large offices spaces as given by the 2008 Buildings Energy Data Book – Table 3.6: Office Building Market and Companies
4. Estimate is based on an average electricity price in California of \$0.128 as given by the U.S. Energy Information Administration.
5. Average was obtained by dividing the total existing capacity of U.S. coal powered generators (335,380 MW) by the total number of existing coal powered generators (1493). Information provided by the U.S. Energy Information Administration.

Office Lighting Controls

- Dimming/switching, tuning, daylighting, occupancy, DR
- 50% aggregated saving potential
- Energy savings: **3,096 GWh/yr**
- Carbon offset:
1.0 M metric tons CO₂/yr



Office Lighting Controls

- Maintenance issues
 - Knowledge barriers could introduce installation issues and problems
- Environmental issues
 - None
- Market potential
 - Significant opportunity for most offices
- Transformation issues
 - Code change requirements
 - Education/training needs
 - Large procurement issues

Bi-Level Exterior Lighting

- Parking, pathways and building façades
- Automatically reduce power to 50% or less on vacancy
- Automatically increase power to 100% on occupancy



Bi-Level Exterior Lighting

30–50% energy savings per fixture

- Energy Savings: **900 – 1,500 GWh/yr**
- Carbon offset: **296 – 493 thousand metric tons CO₂/yr**



Bi-Level Exterior Lighting

- Maintenance issues
 - No issues
 - Longevity benefits
- Environmental issues
 - Longer system life reduces waste stream
 - Short term waste issues created with massive retrofits
- Market potential
 - Most of all exterior lighting excluding roadway lighting
- Transformation issues
 - Requires code changes (T-20, T-24)
 - Educational/training programs
 - Large procurement issues

Commercial Savings Summary

	Energy savings (1000 GWh/yr)		Carbon offset (million metric tons CO2)		Total CA lighting electricity consumption in commercial buildings (1000 GWh/yr)	From	To
	From	To	From	To			
Task/Ambient Lighting	3.1*		1.0*		36.4	9%	
Office Controls	3.1*		1.0*			9%	
Bi-Level Exterior	0.9	1.5	0.3	0.5		2%	4%
Corridors	Results not yet available						
Stairwells							
Refrigeration cases							

* average

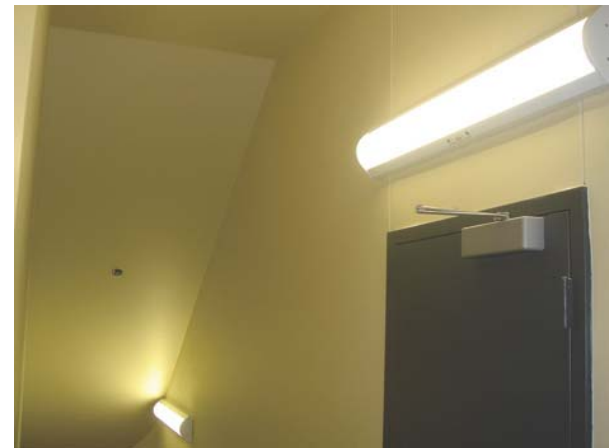
LED Freezer Case Lighting

- More than 40% energy use reduction
- Additional reduction through occupancy/vacancy controls
- ~75,000 refrigerated cases in PG&E's territory
- Market potential
 - Grocery stores, big box retail, gas stations and convenience stores throughout the state
- Transformation issues
 - Requires performance and quality assurance standards



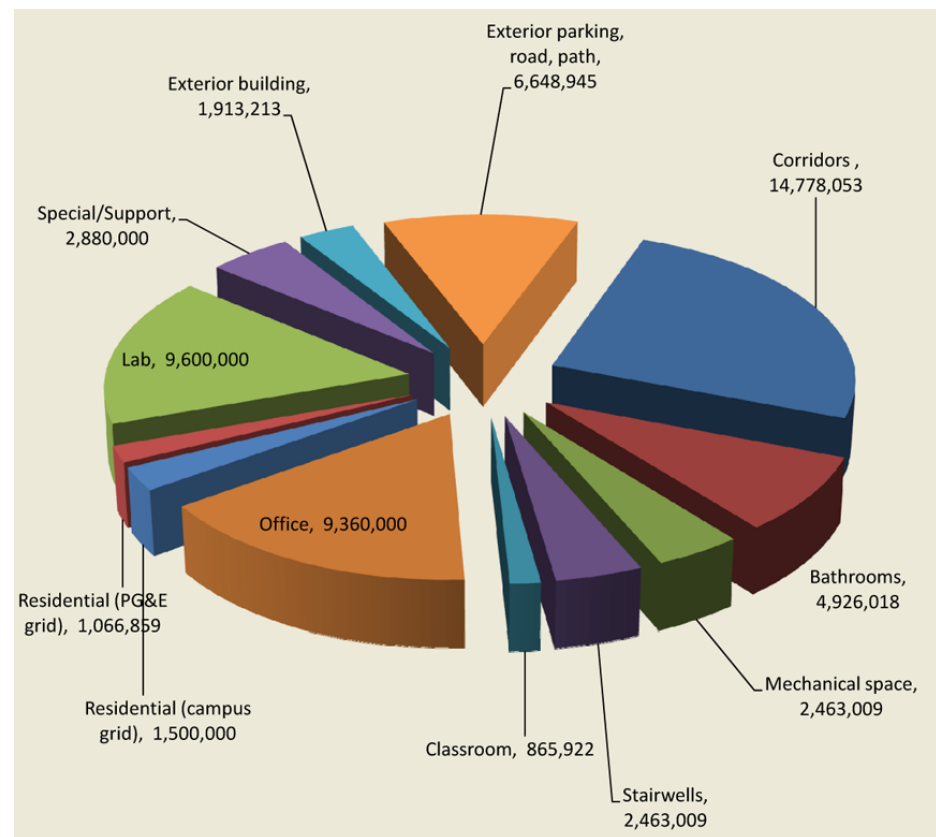
Bi-level Stairwell Lighting

- Up to 70% energy savings over traditional products
- Over 20 years, every fixture can yield savings of 10,000 kWh
- Payback < 1 year for new construction and 1 to 2 years for retrofit applications
- Integrated controls & high-efficiency electronic ballast, reduce system operation and maintenance costs and extend lamp life



Bi-level Corridor Lighting

- New study underway at UC Davis indicates corridors account for **25%** of the annual campus lighting electricity use
- Corridors = **6%** of **total** electric use



Total Campus Lighting:	58,465,028 kWh
Total Campus Electricity Use:	250,000,000 kWh